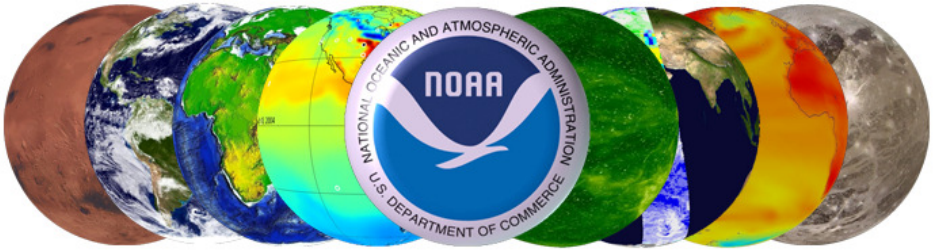
# Science On a Sphere®




# Training Manual

Last Updated Nov. 2007

# Science On a Sphere® Training Manual
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## Overview of Training:

During the setup week for the sphere, NOAA provides Science On a Sphere® system training. SOS system training consists of four separate sessions. There is some overlap between each of the sessions. Each session lasts anywhere from one to two hours.

The four sessions are:

- **Projector Alignment**
- **Operation and Systems Administration**
- **Overview and Basic System Use**
- **Content Creation***

**Note that Overview and Basic System Use is a prerequisite to the session on Content Creation.*

All sessions are taught using the actual sphere system (limited hands-on), so the classes cannot be taught in parallel. Class sizes are variable depending on the interest and usually start by the third day of the setup and wrap up by the end of the fourth day.

## Projector Alignment

Projector alignment is usually the first session given because it corresponds to the final stages of the sphere installation. Once the sphere is installed and aligned, the other sessions can begin. Projector alignment training usually occurs during the first two days of setup. Typically, the site personnel who are responsible for projector alignment are also involved with the SOS setup. Alignment training usually happens in the afternoon of day two of the SOS setup.

What is projector alignment training? The SOS system uses four projectors to display data onto the surface of the sphere. The projectors are positioned around the sphere, 90 degrees apart from each other with respect to the center of the sphere. Each projector is responsible for its quadrant of the sphere. Light from adjacent projectors overlap and make an edge. These edges need to align very closely to achieve a single unified, global sphere image. This edge is also called the blending area. We call the process of creating a seamless edge blend: projector alignment. The instructor will lead a group through the steps required to perform the projector alignment.

## Operation and Systems Administration

This session is intended for the Systems Administrators or IT professionals who will be responsible for maintaining the software and hardware for the SOS system. These individuals will be the primary point of contact for system issues, questions, and problem resolution. The operations and systems administration training typically occurs on day three.

In this session, we will cover a basic system overview as well as a description of the computer components. We go into a detailed discussion of how the pieces fit together and interact. We allocate plenty of time for questions and answers.

## Overview and Basic System Use

This session is useful for individuals who will use the system on a daily basis. It is ideal for individuals who are responsible for bringing up the system in the morning and shutting down the system at night. It is also important for people who will be docents with the sphere to attend this training session. Overview and Basic System Use Training typically occurs on day four. *This session is a prerequisite for the Content Creation training session.*

In addition to the basic functionality of the system, we will cover how content is organized, how to use the system to display data, how to create new play lists and edit old ones, how to use the remote control, and how to give presentations. Also, during this session the trainer will provide a broad overview of the scientific data sets that are available on the system.

## Content Creation

The Content Creation training session is intended for individuals who will create content for the sphere and for people who will work with others to create sphere content. It is also a useful session for people that will be docents with the sphere. The Content Creation training session occurs after the Overview and Basic System Use session on day four.

During this session, the instructor will go into greater detail on the data organization, preferred file formats and how the system interacts with data. Also, all of the options and special features in the playlists will be covered. There will be discussion on how to best go about integrating new content onto the sphere. The instructor will also show the students the steps required to get their own content (both still images and time series) onto the sphere. Individuals are encouraged to bring sample content to try out (NOTE: please review the on-line FAQ on data formats and the Content Creation page first!)

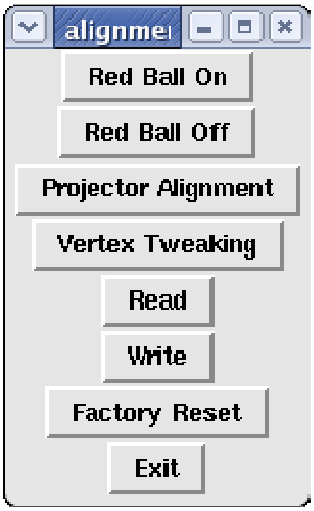
Session 1

# Projector Alignment

In order to optimize the appearance of Science On a Sphere, it is important to have the sphere properly aligned. Because of this, it is suggested that more than one person at the site learns how to align the sphere.

How to Align the Sphere

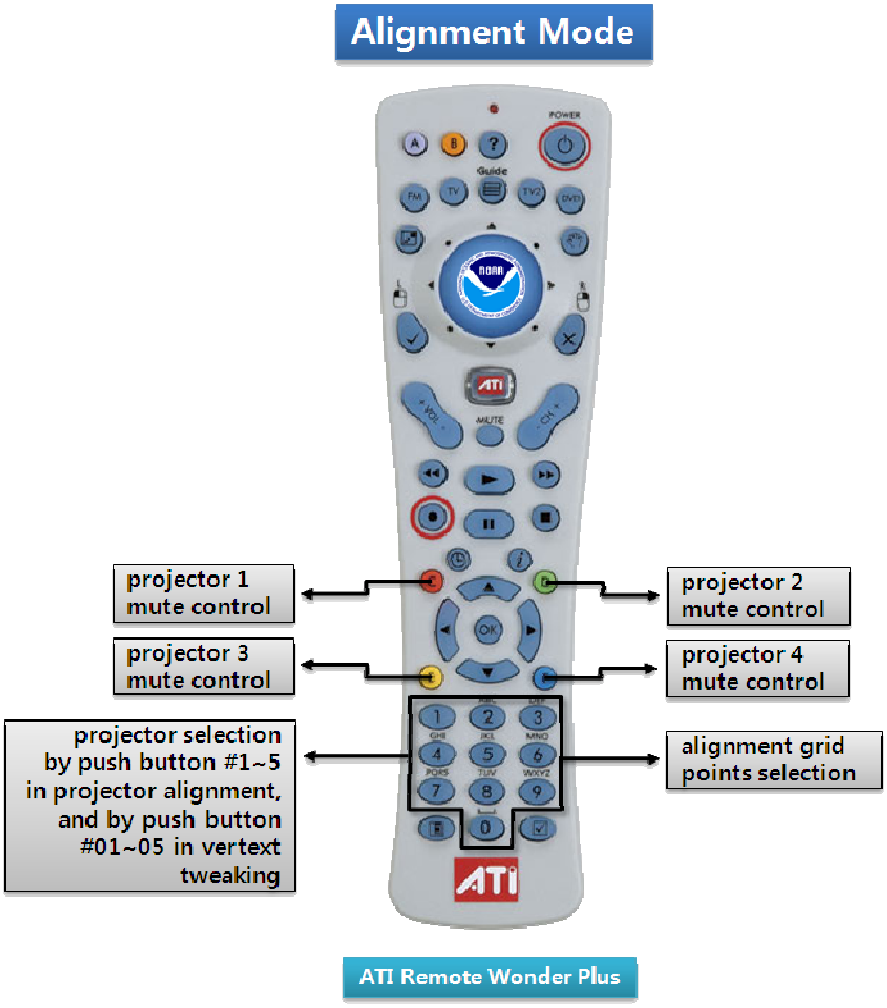
To align the sphere, turn on the system as if you were going to do a demo. All of the computers and projectors need to be on. Open the SOS Stream GUI and load the playlist "alignment.sos." The main dataset that you will use in this playlist is the first one, Red Grid 2048. Once the system is running, you will need to open the Alignment GUI that has been created to help you align the sphere. To open the Alignment GUI, either double click the "Do Alignment" icon on the desktop or type "alignment_gui" in a terminal. This GUI should appear:




There are two main modes for aligning the sphere, one uses the red ball and the other uses the red grid. If you are aligning the sphere for the very first time, or if it is really out of alignment, then start with the red ball. If you are just tweaking the alignment, then start with the red grid.

To use the red ball, click "Red Ball On" in the Alignment GUI. Once the red ball is on, click "Projector Alignment." Make sure the Alignment GUI is the highlighted window because you will use the remote control to align the sphere. If the Alignment GUI is not the highlighted window then the remote will be in presentation mode rather than alignment mode. When you are using the red ball, you only need one projector on at a time. You can toggle the projectors on and off using the remote. The "red," "green," "yellow," and "blue" buttons control projectors 1, 2, 3, and 4 respectively. The goal when using the red ball is to have the red cover the surface of the sphere and not overshoot the sphere on any side. You also don't what to see any cyan on the sphere. You can adjust the position and size of the red ball by using the buttons on the remote.

The numbers 1 – 4 on the remote control which projector you are adjusting. A grid should appear on the sphere for the projector that you are working on. The image can be adjusted in three different modes: translation, scale, and rotation. To turn on translation mode, press 7. In translation mode the arrows can be used to move the image left, right, up and down. To turn on scale mode, press 8. In scale mode, the up arrow makes the image taller, the down arrow makes the image squatter, the right arrow makes the image wider, and the left arrow makes the image thinner. To turn on the rotation mode, press 9. In rotation mode the arrows can be used to rotate the image as necessary. Make sure that you press the mode buttons (7 – 9) firmly because if you are in a different mode than you think you are the alignment can be messed up.




When using the red ball, don't stay in one place. It is important to make sure that the image is evenly positioned on the sphere, so you will have to walk around to see both sides of the sphere. You want everything to be as uniform as possible. Sometimes it is helpful to make the red ball small so that you can center it on the sphere. Once it is centered, then you can expand it until it covers the side of the sphere that you are looking at. The red ball alignment is just the first pass at aligning the sphere, so it doesn't have to be absolutely perfect.

Once you are satisfied with the red ball alignment, close the window that popped up for "Projector Alignment," the click "Red Ball Off." It is probably a good idea to

press “Write” at this point as well. All of the changes that you make to the projectors are only saved when you press “Write.” If you make changes that you don’t want to keep, pressing “Read” will load in the settings from the last time that you pressed “Write.” It doesn’t hurt to press “Write” several times throughout the alignment process to make sure that all of your adjustments are saved every step of the way.

To fine tune the alignment use the red grid. In the SOS Stream GUI, load the dataset “Red Grid 2048” if it is not already loaded from the “alignment.sos” playlist. Once the red grid is on the sphere, click “Vertex Tweaking” in the Alignment GUI. You can again turn the projectors on and off by using the colored buttons as before. You will want all of the projectors on most of the time when Vertex Tweaking. In Vertex Tweaking, you will use the numbers 1 – 9 to select the part of the image that you want to adjust. Because of this, to switch between projectors you will need to press 0 then the number for the projector. (e.g. to switch controls to projector four press 04) The goal when aligning with the red grid is to have all of the lines in the grid line up exactly.

After you have used the remote control to switch to the projector that you want to adjust, you should see a grid of numbers as before. By typing any number 1 – 9 you can select the numbers on the grid. When you have a number selected, you can use the arrows to stretch the image up, down, left and right. The image will only stretch near the selected number, so if a whole side needs to move left, then you need to stretch it at the top, middle and bottom. It is sometimes confusing as to which line is being projected from which projector, so it is helpful to toggle the adjacent projectors on and off to differentiate between the lines. Also, if two lines are separated that shouldn’t be, it is good to move each of them half way and have them meet in the middle rather than moving one line all the way to the other.

Once all of the lines meet in the grid, close the window that popped for “Vertex Tweaking.” Before you close the Alignment GUI make sure to press “Write” in order to save your changes. To perfect your alignment, you can load “Red Grid 4096” from the alignment.sos playlist, which has higher resolution and thinner lines. You will probably have to make some additional adjustments when you put the high resolution grid up. After you load the high resolution grid, make sure to highlight the Alignment GUI again so that the remote will work for aligning the sphere. Click “Vertex Tweaking” to bring up the number grid used in aligning. Follow the same steps as when “Red Grid 2048” was used. Before closing the Alignment GUI, you can load a normal playlist in the SOS Stream GUI and make sure that everything looks good and that there is no overshooting happening. If you have overshooting, you can use “Vertex Tweaking” to correct it. When you are satisfied with your alignment, press “Write” for a final time and exit the Alignment GUI.

You will only want to use the “Factory Reset” button if you physically move your projectors or if the alignment is really off. You will lose all of your current settings if you press “Factory Reset,” so make sure so are careful to only press it when you mean to.

Projector alignment can be a tricky process and is best learned in a hands-on manner. Be patient and remember to walk around the sphere a lot to make sure that you can see everything as you are adjusting. You will be rewarded for all of your effort because a well aligned sphere looks great!

# Session 2

## Operation and System Administration

This section is intended for System's Administrators and others that have responsibility for maintaining the hardware and software components of the Science On a Sphere system (SOS).

### Overview

SOS is a collection of hardware that integrates computers and video projectors to display animated images onto the surface of a large sphere. Taken in pieces, the system consists of a sphere situated in a room, surrounded by four video projectors. Each video projector is connected and driven by a display computer. Each computer/projector pair is responsible for it's own quadrant of the sphere (four video projectors, four computers). There is an additional computer to control them all. Each display computer pulls in content, usually some type of planetary content, renders it to an Earth projection, subsets it, and upon command displays it onto the sphere. The projectors are numbered one through four. Each display computer is named for the projector that it controls with a naming convention something like (sitename1, sitename2, etc). A fifth computer is introduced to control all of the systems. The fifth computer is the network controller for the SOS computing cluster (it's name is usually sitename-nc and is usually referred to as simply "nc"). The "nc" computer is responsible for many things, namely among them: running the main user interface to the system, synchronization of the display nodes, NFS file sharing for content, real time data collection, the router/gateway to the SOS system, and providing the interface to the automation control protocol. All of the computers are Linux based (currently Redhat 4 and Redhat 5). Most sites buy a "hot" spare that is used in the case of a single computer failure. All of the software that drives and controls the SOS system is written and maintained by NOAA.

### System Specifications

Each node in the SOS system is a standard computer system with mid to high-end graphics hardware. The system is generally specified so that each of the nodes are identical from a hardware perspective to allow easy swapping of components (in case of system failures).

Projectors are usually specified so that they work well in high duty hour environments. Mostly, projectors classified as "board room" projectors meet this requirement. These projectors typically have multiple fans to provide adequate cooling during the day. The projectors are also specified so that they produce a high light output (LUMENS), mostly in the range of 3500 to 5000 LUMENS.

### Network

The computers are connected via a gigabit network to enable high speed communication and data transport. The SOS computer cluster mostly resides in a private, non-routable network space (usually in the 10.x.x.x network range). Each computer is isolated from the network at large because of their special purpose responsibility. The "nc" host however, usually sites on the border between the private SOS network and the sites local Intranet. NC runs kernel based firewall package to

protect against undesirable traffic. The firewall filters are usually designed to drop every incoming connection, except secure shell access. NC sits at the border of the network to enable outside access for remote systems administration, software updates, and to pull down real time data from the NOAA servers. While the local, private SOS network is gigabit, the external connection can be whatever the local site supports in their network infrastructure.

File Serving

NC is the file server for the cluster. All the display nodes in SOS rely on nc to provide access to the SOS display software and data. NC is a common link between all of the nodes. When the systems boot, nc should be booted first and when the systems are powered down, nc should be powered down last.

Backups

No data is backed up by default. In general all of the data that comes with the system can be retrieved from NOAA, however, there are some data files that are site specific. Here are some examples of site specific data: the custom playlist data in the SOS home directory on "nc"; the alignment configuration files that are in the home directory of each display node (usually the "sos" user); any custom or local site content that was developed and installed on the system.

It is a sites responsibility to back this content up. Generally, the playlist and alignment data are a few megabytes (usually much less). However, to back up custom content can sometimes be many gigabytes.

Power Down Schedule

Generally, it is recommended that the entire SOS cluster remain powered up all of the time if you receive real time data. The projectors only need to be on during operation and should be powered down to save lamp life. If system power down is required, then it is recommended to halt the SOS software, then halt each display node (a single press of the power button starts a graceful clean shutdown), then halt "nc" (power button click).

System Maintenance

Projector alignment should be checked frequently (once a day, ideally during the normal startup for the day) to ensure that the system is aligned properly. Usually, the system only gets out of alignment when there has been some disturbance to the projectors. It is recommended to check it daily just to ensure that the system is displaying data in an optimal manor.

Projector Filters and Lamps

Projector lamps are one of the main consumables for SOS. A typical projector lamp lasts anywhere from 1500 to 3000 hours. The image quality of the system should be checked on occasion. As a projector lamps ages, it will start to dim or show discolor and then in many cases, suddenly go out. In some cases the projector will turn on a lamp warning light indicated a new lamp is needed. It's not a bad idea to have a spare lamp on hand in case of a sudden failure. In general, it is a good idea to follow the manufactures recommendations on lamp replacement. When lamps are replaced because of age, it is

also recommended to replace all of them at the same time, since the color and intensity difference between an old bulb and a new bulb will make the sphere visualization look bad.

Projector filters should be checked monthly to ensure proper airflow. At minimum, every quarter, but that depends largely on the projectors environment. Dusty areas require more frequent filter cleaning. Dirty filters reduce cooling capacity and shorten projector lamp life. This is probably the most important of the maintenance tasks to perform.

Computer Maintenance

The SOS systems are like any other computer system. In general they run and run without the need for maintenance. Redhat releases operating system patches frequently and patches that effect security should be applied as needed. If NOAA comes across an operating system patch that adversely effects system operation, we will let sites know through the SOS Forum.

User Accounts

Every process that runs under Linux must have a user id. The SOS system uses two user id's: sos and sosrt. The user id sos is used for day to day system operation and running the SOS software. The sosrt user id is run in the background by the processes that mange and transfer the real time data feeds. Administrators of Linux sometimes need access to the super user account (equivalent to the Windows "administrator" privileges). The super user account in Linux is called "root". The password is set at machine installation and can be changed locally at the site. It generally considered safer, or at least a better practice, to not use root directly, but rather use the "sudo" command that temporarily raises a normal users privilege to root for the duration of a single command.

# Session 3

## Overview and Basic System Use

Most of the Science On a Sphere® software has been written so that it is easy to use. This session is meant to familiarize users with the basics of the Science On a Sphere® system.

### Starting Up the System and Shutting it Off

Before the system can be used, all of the computers must be turned on. The control computer must be the first computer turned on. Make sure to turn on the rest of the computers as well (projector computers one through four, and the hot spare [optional]). The control computer will automatically log on to a preset user account. If you want to change users you will have to log out and then log in using your user name and password that has been set.

Once you are logged in, find the icon on the Desktop labeled “SOS Start” (pictured right) and double click it. This will bring up the Science On a Sphere® interface, the SOS Stream GUI, needed to run Science On a Sphere®. A control window will open as well as a terminal. You don’t need to do anything with the terminal, but don’t close it because closing that terminal will close the SOS Stream GUI as well. You can minimize/iconize the terminal window if it is a nuisance visually. If you are going to be giving a presentation, the projectors must also be turned on. Use the provided remote to turn on each of the projectors.

To shut the system off there are several options. The recommended method is to simply press the power button once on each machine. This will initiate a graceful shutdown. The control computer should be the last one shut down. The second method is to can click “Actions” from the upper panel and select “Log out.” (pictured left) This will give you the choices of Log out, Shut down, or Restart. You can also type "sudo shutdown -h now" to shutdown or "sudo reboot" to reboot in a terminal. To force a sudden power off you can hold the power button for 5 seconds. This last option is to be used only as a last resort.

### SOS Stream GUI

The SOS Stream GUI is what you will use to open playlists and give presentations. At the top of SOS Stream GUI you will see four menus: “SOS,” “File,” “Library,” and “Controls.” There are also buttons similar to those on a VCR that allow you to control the opened playlist.

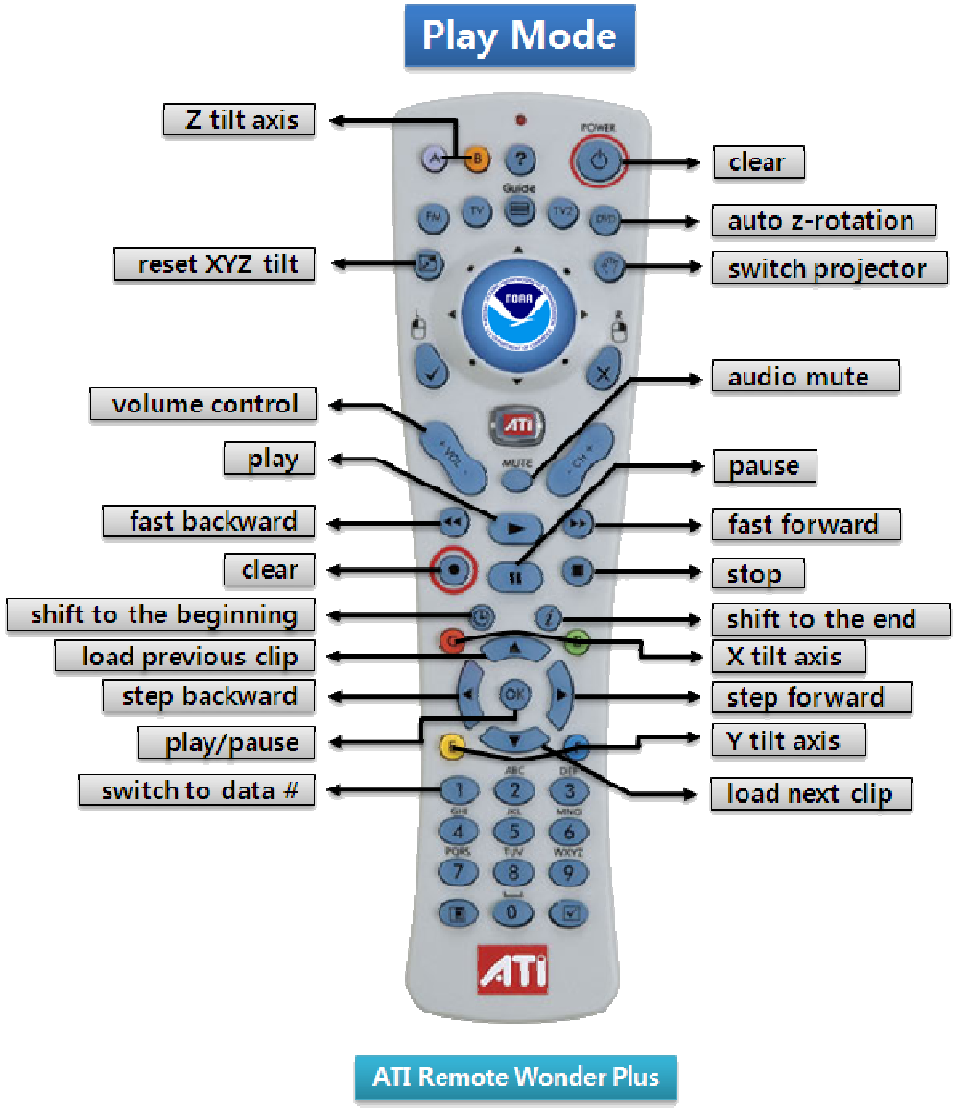
### Opening a Playlist

A generic playlist is automatically opened when the SOS Stream GUI is started. To open a saved playlist, click on the “File” menu and select “Open Playlist.” In the window that appears, select the playlist that you would like to use. All of the playlists are saved in the directory: **/home/sos/sosrc**. (**/home/sosdemo/sosrc** for some sites)

If you make changes to your playlist while it is open, it will not automatically reflect those changes. You will need to reload the playlist by clicking the “Reload Current Playlist” button in the “File” menu.

Using a Playlist

Once a playlist is open, there are several options of how to use it. The first is to set the system on autorun mode. In this mode, the system will run through the playlist on an automatic timer. To turn on autorun, click "Autorun" under the "File" menu. The second is to control the playlist from the control computer. To do this you can use the buttons across the top of the window, the commands in the "Control" menu or the keyboard. The buttons across the top of the window are similar to those on a VCR. There is a timeline across the top with a slider bar to indicate the time in a dataset. You can move the slider bar around with the mouse to fast forward or fast backward the dataset. The commands in the "Control" menu provide all the same functions as the buttons across the top. The controls for the keyboard are listed the right side of the commands in the "Control" menu. The most common keyboard commands are the up and down arrows that allow you to move through the selected playlist, and the space bar which pauses and plays the datasets. The third way to control the playlist is using the remote control. You can perform all of the same functions on both the remote and the computer. The controls for the remote are highlighted in this image:



Functions of the Remote

The remote is a great tool for docents to use while giving live presentations. The main functions that are used most often are straightforward. Once you have opened your desired playlist, click on the first dataset. Using the remote, you can select the dataset by typing the number of the dataset in the lineup. The pause, play, stop, fast forward, and fast backward do exactly what you would expect them to do. To step backward or forward slowly, use the side arrows. To shift to the end of the dataset, use the button with an "i" on it and to shift to the beginning, use the button with a clock on it. The up and down arrows let you move to the previous and next datasets respectively. These buttons are very sensitive and one light press is all that is needed. If the button is held too long, then it will go through multiple datasets quickly.

The slightly less intuitive buttons are the ones used to tilt and position the image on the sphere. The red and green buttons tilt the dataset on its x-axis, the blue and yellow buttons tilt the dataset on its y-axis and the purple and orange buttons rotate the dataset on its z-axis. (*NOTE – the orientation of the x and y axis is not the same for all datasets*) If you want to reload the dataset in its original orientation, use the third button from the top on the left (with a square on it). If you want to reload the dataset so that its position is shifted by 90°, use the button with the hand on it. To clear the dataset completely, use either the power button or the button with a circle. Animated datasets can be made to rotate by pressing the DVD button. All of these functions are also available under the "Control" menu.

Organization of Data

Before you make playlists, it's helpful to understand how the data is organized. All of the Science On a Sphere® datasets are put into one of the five main categories. These categories are:

- Astronomy
- Atmosphere
- Land
- Models and Simulations
- Oceans

There is also an "Extras" category that contains assorted clips and videos that don't fit into the above categories. Within each category there are many datasets. While there are some datasets that could fit into multiple categories, we keep them in just one category to remove redundancy. A full list of all of the datasets available in the categories is available on the SOS website at: http://sos.noaa.gov/datasets/

Every category has a directory that contains a folder for each dataset in that category. The dataset folders contain all of the data and information that you need to put the dataset up on the sphere. You will see all of these directories at /shared/sos/media/ on the control computer. Each dataset folder contains (if available):

- P1, P2, P3, P4
- Texture file (if still image)

- Folder with raw images named for the size of the images
- An equatorial cylindrical equidistant video (.mp4) of the data
- Text file labeled labels.txt
- Text file labeled playlist.sos
- Color bars and other supporting images
- Media folder with thumbnails, videos, and supporting documents

A uniform naming convention has been used among the folders. Images that are projected onto the sphere are named for their size, movies that are projected onto the sphere are named for their dataset name and size, all labels are named labels.txt etc. This was done to make it easy for the user to know what is available in each folder.

Datasets that are related to one another are all grouped into one folder. Each dataset still has its own folder, but then those folders are all put into one folder. For instance, in the "atmosphere" category there is an "aerosol" folder. This "aerosol" folder contains three folders, one for each of our related aerosol datasets.

Two Types of Datasets

There are two main types of datasets, textures and time series. Textures are the simpler of the two. They consist of one still image that can be set to rotate around the sphere. A good example of a texture is Mars. In the Mars folder you will find just one image, named for its size, which is projected on the sphere. Often, the textures are available in several different resolutions. As the resolution increases, so does the loading time on the sphere. Textures can be rotated in any way using the functions either in the "Control" menu or on the remote.

The second type of dataset is a time series. An example of a time series is the Indian Ocean Tsunami; you can watch the waves propagate across the globe. There are several different ways that time series work. In its raw form a time series is a collection of images. The images are named numerically, in ascending order. All of these images are in a folder named for the size of images. These images can be used to display the dataset on the sphere, but you cannot rotate the dataset about on its axis's. To add versatility, the raw images can be converted to a MPEG4. MPEG4s are named for the dataset and the size of the movie. MPEG4s allow you to take advantage of all of the features available in the "control" menu or on the remote. This is the preferred format for showing time series. The MPEG4s and raw images can also be set to rotate while they are animating by clicking the DVD button on the remote. Some of the older datasets play using folder labeled P1, P2, P3, and P4. Each of these folders contains the images that each projector displays. This is the least preferred method of displaying datasets. None of the additional rotation features are available when using the P folders.

*NOTE: Even if you make an MPEG4, it's good to keep the raw data available.*

Playlist.sos

Within each dataset folder is a text file named playlist.sos. This file is used to specify how the data is displayed on the sphere. There is a fairly strict format that must be followed within the playlist.sos file. Any specifications that are made in the

playlist.sos will be used in all of the playlists that include that dataset. Here are the parameters that can be included in the playlist.sos file:

name = Name show on menu ( must specify )
Name or label for the playlist entry. The name is used as text for the play list item button on sos_stream_gui

rename = Over ride "name ="
This is a way to over ride the "name=" from an included play list

data = name of the data file (can be JPEG, folder of JPEGs, MPEG4 or P1)
if opengl = 1, then it must end in a ".jpg" or some other image file name.
datadir = Depricated keyword. Replaced by the new keyword "data ="

background = path to a single frame of data
Specifies the path to a background image (e.g. such as a topography image). Can be used in conjunction with "data=", where the "data=" specifies a time sequence of cylindrical data files that have an alpha transparency channel set (usually .png files). This gives a basic overlay capability.

fps = frames per second ( 30 if not specified )
How quickly the animation sequences through data frames.

pip = image
The pip, is an image or MPEG4 file that will appear in a picture in a picture window on the sphere. The pip window appears based on the values set by the other pip control keywords. Multiple pip's may be specified

piptimer = 10
Length of time pip is displayed excluding fadein/fadeout (seconds)
Use a value of 0 for "duration of clip."

pipdelay = 5
Time delay before pip is displayed (seconds)

pipwidth = 45
Width in degrees of longitude

pipheight = 45
Height in degrees of longitude

pipalpha = 0.8
Opacity of pip over underlying image

pipfadein = 1
Length of time pip takes to fade in (seconds)

pipfadeout = 2.5
Length of time pip takes to fade out (seconds)

pipvertical = -10
Vertical position of pip center above equator (degrees)

piphorizontal = 0
Horizontal position of pip center east of projector subpoint (degrees)

slide = image
slide show image come via the 2nd port of Graphic Card to side wall projector or big screen monitor.

firstdwell = number in millisecond
lastdwell = number in millisecond
firstdwell and lastdwell. Specify time in milliseconds that the animation will stop on the first and last frame. Defaults to 0 milliseconds.

startframe = [some frame number] ( default is 1 if not specified )
Trim a long animation. If specified, the animation will only display frames beginning at "startframe" and going through "endframe".

endframe = [some frame number] (default is the last frame)
Trim a long animation. If specified, the animation will only display frames beginning at "startframe" and going through "endframe". Endframe values can be absolute frame numbers, or if they are negative, the frame number is relative to the end of the animation. The endframe can also be the key value of "end" to specify the end of the animation

label = [default ( displays frame filename ) | /path/to/labels.txt ]
No labels will show, if not specified, otherwise the label file contains on line per frame of that animation. This is usually used to specify a data/time stamp for a frame sequence. Label files are ignored for singe texture clips.

audio = /path/to/audio/file ( no audio if not specified )
The audio file can be anything that Linux audio player "Mplayer" can decode. Examples of
valid audio file formats are: .mp3, .wav, .ogg, or .mp4

opengl = [true | 1 | 0] (Depricated keyword)

This keyword is no longer used and this capability is figured out dynamically based on the
value of "data="

skip = n (where n is the skip factor for a directory of files.
skip = 1 will skip every other file in a animation,
skip = 2 will play every third file, etc).
As skip gets bigger, total files animated over, goes down.

tiltx = number of degrees of tilt in x-axis.
tiltx only works if the data specifies a cylindrical data set (either in mp4 or an image sequence)
tilty = number of degrees of tilt in y-axis.
tilty only works if the data specifies a cylindrical data set (either in mp4 or an image sequence)
tiltz = number of degrees of tilt in z-axis.
tiltz only works if the data specifies a cylindrical data set (either in mp4 or an image sequence)

zrotationenabled = [0 | 1]
An SOS data set (time series data) can be rotated while the data is animating through time. Only supports animating around the z-axis (generally the axis that passes through the north and south poles.
Zrotation only works if the data specifies a cylindrical data set (either in mp4 or an image sequence)

zfps = frames per second (default 50)
Rate at which the zrotation feature animates. Only valid if zrotationenabled is 1

zroationangle = angle in degrees (.1 degrees by default)
Number of degrees of rotation for each time step during the zrotation.
Only valid if zrotationenabled is 1

timer = number of seconds (180 sec if not specified )
timer is used in "auto presentation mode only".
Specfies how long to play a presentation.

labelColor = R, G, B, Alpha ( "White" if not specified )
(also can use symbolic names: white, black, red, green, blue)

labelposition = [ default | x,y (range from -1, -1 ~ 1, 1 ) ]
( -0.3, -0.5 if not specified )

animate = [ 0 | 1 ]
(if 0, then don't immediately start animating when item is loaded (must hit play). Otherwise, automatically

animate when playlist entry loads. In auto presentation mode, always animate, even if animate = 0

category = "a string identifier"
Categorization of this data

keywords = comma separated list of keywords
keywords to aid in searching

publisher = a string identifier
The name of the person or organization who published this data

creator = a string identifier
The name of the person or organization who created this data

stopframe = (some frame number)
Stop animating when the animation reaches this frame number

Because all of the data is stored in the same folder as the playlist.sos file, it is not necessary to include the entire path to the file. You only need to include the data name. For example, to include labels all you need to type is *label = labels.txt*.

A typical playlist.sos file will not include all of these parameters. At very minimum, "name" and "data" must be included. It is also recommended to always include keywords, publisher, creator, and category. Also, anything with a "#" in front of it is commented out and won't affect how the dataset is displayed. If the data was taken from online, it is often useful to include the web address of the data's original location.

Playlist Format

A playlist is an ordered list of datasets. It is often helpful to think of a SOS playlist as a music playlist in iTunes. Playlists can be saved and repeatedly used. Different playlists can be made for different presentations or shows. Also, docents can have their own playlists. All playlist file names have to end with the extension .sos. The basic format of a playlist is a file that points to all of the playlist.sos files that are in the dataset folder. For example, here is a playlist that includes three datasets:

*include = /shared/sos/media/oceans/indian_tsunami/playlist.sos*
*include = /shared/sos/media/astronomy/xray_sun/playlist.sos*
*include = /shared/sos/media/models/ipcc_temp/gfdl/playlist.sos*

Each "include" is used to point to a different dataset. This example playlist includes the Indian Ocean Tsunami, the X-Ray Sun and the GFDL Temperature Change Model. All of the information about the labels, color bars and timing is saved in each of the separate playlist.sos files. The nice thing about this format is that everyone's playlists will be using the same versions of the data. However, if you do want to edit some of the options for a dataset, within only your personal playlist, you can do that. Simply include

the changes in your demo playlist under the include. For example, if you want a faster rotation rate on the sun and a longer lastdwell for the tsunami in your playlist, you can change it like this:

*include = /shared/sos/media/oceans/indian_tsunami/playlist.sos*
*lastdwell = 7000*
*include = /shared/sos/media/astronomy/xray_sun/playlist.sos*
*fps = 50*
*include = /shared/sos/media/models/ipcc_temp/gfdl/playlist.sos*

Making a Playlist

There are two basic ways to make a playlist. The first is to manually type the playlist in a text editor and save the file with a .sos extension. For this you will need to know the path to each of the datasets on your control computer. There is also a playlist editor that you can use to make your playlist. This is a good option if you don't know where all of the files are located. The editor is a drop and drag program that lets you drop and drag datasets into your playlist and then rearrange them as you please.

Giving a Presentation

Presentations with Science On a Sphere® can take on several different formats. The simplest is autorun. In the autorun mode, the system displays each dataset for 3 minutes (if not specified otherwise) before moving on to the next in the playlist. This is a good option when a docent is not available to lead a presentation. If this format is used, it's nice to have supporting audio or text so that the audience knows what they are looking at. We have audio tracks available with a limited number of datasets. The available audio tracks are in the dataset folders. Side wall projectors or flat screen televisions can be linked to the Science On a Sphere® software to sync a PowerPoint presentation with a SOS demo. This can be used to display supporting information for each dataset.

The preferred way to present Science On a Sphere® is with a live presenter to lead the audience through a playlist. The presenter can either be around to answer questions as visitors wander through or lead a structured presentation on a schedule. The length of a presentation can vary widely depending on the audience and topic. A standard presentation at the Planet Theater at NOAA in Boulder, CO is 30 – 45 minutes and includes 10 datasets on average.

Many sites give live presentations with the sphere throughout the day, and in between presentations leave the sphere on autorun. Presentations can be broad and include datasets from all of the categories, or narrowly focused on a topic such as climate change or the solar system. The type of programming is entirely up to the users.

Another aspect of the presentation that needs to be considered is if the audience will sit in one location or move about the sphere. With the rotation capabilities of most datasets, it is possible to have your audience seated on one side of the sphere and rotate all of the datasets to be ideally positioned in front of them. The second option is to have the audience walk around to different sides of the sphere, rather than rotating the data. There are pro's and con's to both options, so it's up to the users to decide which option best fits their needs.

# Session 4

## Content Creation

Knowing how to create and add content to your Science On a Sphere® allows your site to have the latest and most up-to-date datasets. Members of the SOS users group often share the content that they create with the other SOS sites. This session is meant to familiarize users with the process of creating content.

Data Organization

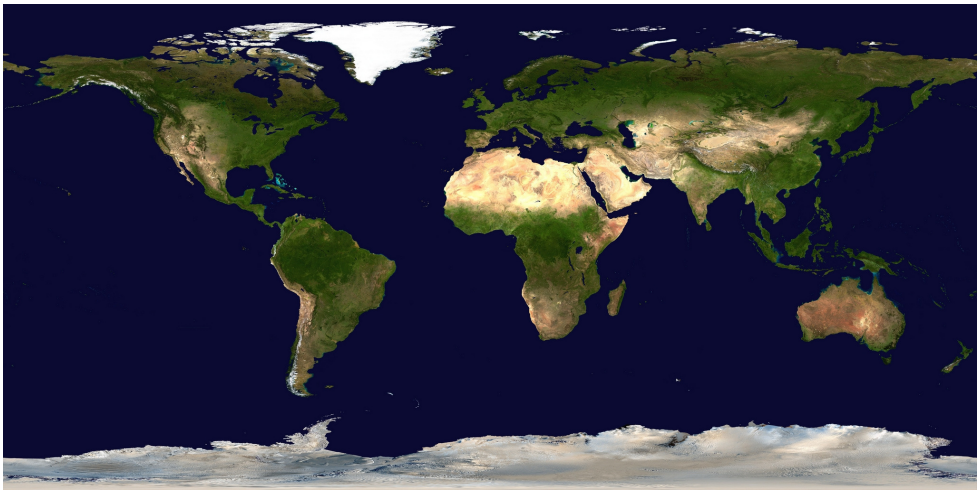
As covered in the last section, each dataset has its own folder that contains all of the pieces that are needed to put the image up on the sphere. The only two pieces that you must absolutely have to use a dataset is the image or images and a playlist.sos file. All of the other pieces, such as the labels and color bars, are optional but nice to have. Every folder is stored in one of five categories. It will be helpful for your site to continue with the data organization method as you add your own data so that is easy to locate and use. In some cases, it is useful to create a category called "Proto" or "Prototype" where you can store new datasets that you are working on.

Types of Datasets

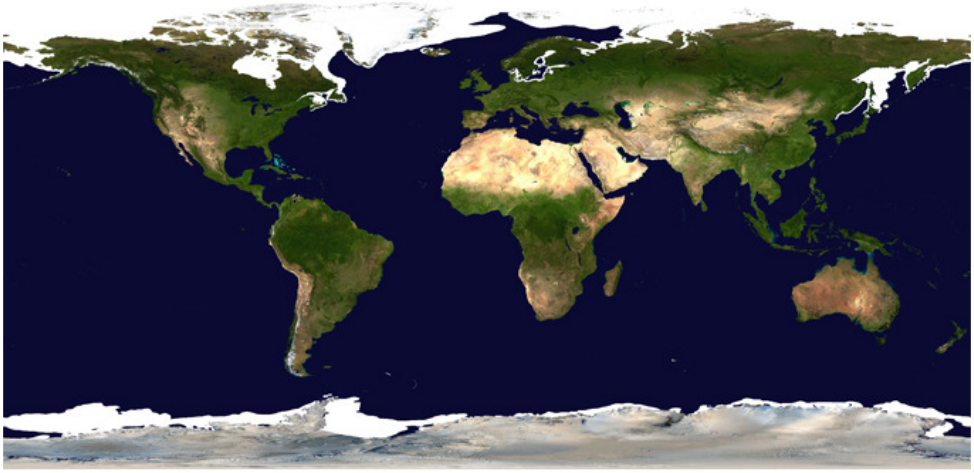
We've already that mentioned that there are two main types of datasets: textures and time series. Textures are a single, static image that can be set to rotate about the sphere. Texture datasets are relatively simple to make because you only have one image to work with. You can set the rotation rate of a texture by setting the frames per second (fps) setting in the playlist.sos file. Making a time series can be a little more difficult. There is no limit on the number of images that you include in a time series, except for available disk space. You can animate the time series at any rate, but 30 frames per second is the recommended speed. We try to create our data so that they look smooth and animate well at 30 fps. The frame rate is sometimes limited based on the pixel resolution of the data and the type of data. It is important to keep this in mind when creating a time series so that you make enough images to ensure that the dataset plays for a reasonable length. If you only make 30 images, then it will only take one second to loop through the dataset at 30 frames per second. The optimal playback speed is chosen based on the number of frames and the degree of change between each data frame in the sequence. To get smooth animations the changes between each frame should be small and the playback speed high. If a dataset is coarse, then it might animate better as a slower frame rate such as 10 – 15 fps.

For making time series, you should consider using a background image that you can then layer data on top of. You have to use PNG's if you are going to do this because they allow for transparency. This provides a great way to save disk space, because you only need one background image. The images that have data are much smaller files. Here is an example of a background image and a transparent data frame that you can layer on top of one another:

Sea ice concentration image with transparent background



Background base map for the sea ice concentration data



Sea ice concentration image layered on top of background base map.

File Format

In order for the data to wrap properly around the sphere, it is imperative that you follow the specifications for the data format closely. Images in the wrong projection format will project on the sphere, but they won't look good. The images need to be plotted on an Equatorial Cylindrical Equidistant (ECE) projection. An ECE projection is commonly referred too as a simple lat/lon grid, where the image is a standard cartographic map projection that is twice as wide as it is tall (rectangular). 2048x1024 is the minimum acceptable size, though 4096x2048 is recommended to optimize the appearance of the image on the sphere. The SOS system is fairly flexible as to what file formats it can handle. It will accept most common format such as GIF, JPEG, PNG, TIF, etc. We prefer JPEG or PNG. If you want to use a background image and then layer data on top of it, then you should use PNG because it allows for transparency. It is important that the data fill the entire image space. If there are borders or extra space around the edges then seams will appear on the sphere with spots on the poles.

For texture data you just need one image. To be consistent with the organization, the texture images that you create should be named for their size. For a time series you need a sequence of images. The image file names should sort in ascending order from earliest to latest. To do this, we usually embed a frame number in the file name, with a sufficient number of leading zeros where necessary to sort correctly. When you create a time series, the images should be kept in a folder named for the images' size.

System Interactions with Data

When a dataset is projected on the sphere, you are really looking at four images that have been merged together seamlessly around the sphere. The Science On a Sphere® software splits the ECE images that you load using the SOS Stream GUI into four disk images every time you load a new dataset on to the sphere. Because all of the work is done by the software automatically, you don't need to do anything except point the system to where the data is located by creating a playlist.

Tools to Create Datasets

Because Science On a Sphere® uses common image formats, you can use many tools to create and edit datasets. Some of the common tools used are Photoshop, FinalCut Pro, ImageMagick, GIMP, etc. You can use whatever you have available and are comfortable using. A program like FinalCut Pro can be used to add transitions, special effects and other computer graphic techniques. At a higher level, tools like IDL, AWIPS, McIDAS, and other image analysis applications are typically used to create imagery from scientific datasets. As an example, we have used AWIPS (Advanced Weather Information Processing System) to create images from numerical forecast models. A graphics designer can use a 3D modeling application, such as 3D Studio, to create advanced visualizations for SOS.

Animation Options in the Playlist

You can optimize how a dataset is displayed by understanding all of the options that are available to you in the playlist.sos files. You can do much more than simply display the dataset. All of the functions available for the playlist are listed above in the

Overview and Basic System Use section. Now we will go over how to best use all of these functions available.

For a texture dataset, there are only a few options that you need to consider. When a texture dataset is initially loaded on the sphere, you can set whether you want it to rotate immediately or only after play is pressed. The function "animate" in the playlist controls this. If "animate" is not included in the playlist, then the default is for the dataset to automatically start rotating. "animate" can be set to either 0 or 1. 0 will prevent the dataset from animating until play is pressed, and 1 will cause the dataset to start rotating immediately when loaded. Another common function used with textures is the tilt options. For instance, we have our Earth textures set to load at a 23.5° tilt to resemble the Earth's actual tilt. This is also useful if you are loading a dataset that highlights the poles, which are hard to see if there is no tilt. To set the tilt, use "tiltx," tilty," and "titlz" to the number of degrees that you want each axis tilted. The tilt can be positive of negative.

For a time series, you have all of the options mentioned for the texture, plus many more. Rather than causing a dataset to rotate, "animate" causes a time series to start animating, but the functionality is the same. The default is for the dataset to start animating immediately. When a presentation is docent-led, it is often helpful to have the time series animate only after play has been pressed. This gives the docent time to provide background information about the dataset and explain what is going to happen. (In autorun mode "animate" is automatically set to 1 regardless of what is in the playlist.) Another option is to set "firstdwell," which is an amount of time that the system lingers on the first frame before animating. The default is zero seconds. The time is listed in milliseconds, so "firstdwell = 4000" will dwell on the first frame for 4 seconds. You can also dwell on the last frame by setting "lastdwell." When "lastdwell" is not set, the dataset loops continuously without pausing. Especially with model data, it is nice to set "lastdwell" so that the audience can get a good look at the last frame before the dataset loops again. If you want to stop the animation, you can set "stopframe" to the frame number that you want the animation to stop on.

With particularly long datasets it's sometimes nice to show only a piece of the dataset. You can do that by setting the "startframe" and "endframe" to the frame numbers that you want to start and end on. An example using this is when we just want to show a loop of Hurricane Katrina formation and path. We use the 2005 Hurricane dataset, but set the "startframe" and "endframe" so that we only show the piece of the dataset when Hurricane Katrina was visible. The "endframe" can be a negative number, which counts back from the end. Another way to shorten a dataset is to set the "skip" option, which allows you to set a skip factor. When "skip" is set to one, it skips every other image, and when it's set two, it skips every third image.

Another option that you have for times series is to not only have them animating, but also rotating. For example, the default for the Indian Ocean Tsunami dataset is for the base image to stay stationary while the waves propagate across the ocean. This means that only the audience standing in front of the Indian Ocean can see the waves. When "zrotationenabled" is set to 1, then the dataset will rotate about its z axis while it animates. You can also use "zfps" and "zrotationangle" to set the frames per second rate for the dataset and the angle at which the dataset rotates. Make sure that you set your "zfps" at a rate that allows your audience to still grasp what they are looking at before it

rotates out of site. For especially busy animations, it could be distracting to the audience to see both the animation and the rotation.

There are also some functions in the playlist that should be specified when using auto run. Auto run mode cycles through the datasets in a playlist automatically, showing each dataset for a specific amount of time. You can specify the amount of time each dataset is shown by setting "timer" to the number of seconds desired. If this is not specified, then each dataset is shown for 180 seconds. If "timer" is specified and you are not showing the playlist in autorun more, then "timer" will be ignored. It's important to use "timer" when you also have accompanying audio tracks. You will want to make sure that the audio is synced with the playlist. You can set audio for each dataset by specifying the desired track with the "audio" keyword. The audio tracks must be compatible with the Linux Mplayer such as .mp3, .mp4, .wav, or .ogg. Audio tracks are available from NOAA for a limited number of datasets. They provide a good way to give your audience information when a docent is not available.

Picture in a Picture

Picture in a picture (pip) allows you display pictures (any of the previously mentioned image formats works) or videos (MPEG4 only) on top of any dataset. This feature can be used to display any image, but is commonly used to display color bars, charts and graphs, and other images that supply supplement information. Also, you can have multiple pips which can be either displayed all at once, or set to run like a slide show on the sphere. For example, we have a Mars dataset that has all of the landing sites on Mars labeled. To compliment this, we use pips to cycle through a slide show of images taken from different exploration trips to Mars. Images that you are going to use as pips can be stored in the dataset folder that they go with. When a pip is included, there are several options that you have to set.

The "piptimer" has to be set (in seconds) so that the system knows how long to display the pip. If the "piptimer" is set to 0, then the pip will be displayed for the duration of the dataset. You can delay the appearance of a pip by using "pipdelay," which is in seconds. Rather than having the pips appear abruptly, you can use the "pipfadein" and "pipfadeout" to fade the pip in and out in a specified number of seconds. The time to fade in and out a pip is excluded in the total amount of time allotted in for the "piptimer."

In order for the pip to be an appropriate size for the sphere and in the proper proportions, you have to set the "pipwidth" and "pipheight." The width and height are measured in degrees longitude, so it is helpful to know the original proportions of your pip when are determining the "pipwidth" and "pipheight." You won't want to make your pip more than 90 degrees wide because the pip appears four times (once for each projector) and it will start to overlap. In addition to the pip size, you will also need to determine where you want it displayed on the sphere. If nothing is specified, then the pip will appear in the middle of each of the projector views. To adjust the position of the pip, use "pipvertical" and "piphorizontal." Both of these are in degrees. "pipvertical" is the vertical position of the image relative to the equator, with positive degrees above the equator. Be careful as you move the pip up and down as images near the poles become warped. The horizontal position is relative to the center of the projector, with positive degrees east of the project. The final option to set with a pip is "pipalpha," or opacity. If

not specified, the pip shows up opaque. If you don't want your pip to completely block the underlying image you can adjust the opacity of the image from 0, which is completely transparent to 1, which is completely opaque.

Labels and Color bars

Labels and Color bars can be in the raw images or projected on top of them externally. It is recommended that you do not add the labels and color bars directly to the images that you create. By keeping them as external images, you have much more flexibility with their size and position within the playlist.sos file. If you do choose to put you labels and color bars directly on the images that you create, make sure that you make them big enough so that they are legible on the sphere and that they are far enough from the poles that they don't get too warped.

One of the nice things about keeping the labels and color bars external is that they don't move as you rotate a dataset. They stay in the same position relative to the projectors. Labels and color bars that are part of the image rotate with the image, which can cause trouble as you move the sphere about. Within the playlist.sos file you can set the position using "labelposition," which is set by the x and y position as a pair of coordinates (x,y). Both x and y can vary from -1 to 1. The default position is (-0.3, -0.5). The label color can be changed with "labelcolor" which can be set to R, G, B, Alpha, (or the symbolic names: white, black, red, green, blue…). The default color for the labels is white.

The labels are a simple text file that contains one line for each image in the dataset. If you have a label for a texture, it will only be one line. If you have labels for a times series that contains 2000 images, then you need a text file that has 2000 lines. In the playlist.sos file, if *label* = *default*, then the image file names appear as the labels on the sphere. You can easily create your labels using any text editor. The label file is stored in the dataset folder and is named labels.txt. Typically the labels contain the date and maybe a title. Here are some examples of labels.txt files:

```
07/24/2004 06:45
07/24/2004 07:15
07/24/2004 07:45
07/24/2004 08:15
07/24/2004 08:45
07/24/2004 09:15
07/24/2004 09:45
07/24/2004 10:15
07/24/2004 10:45
07/24/2004 11:15
07/24/2004 11:45
07/24/2004 12:15
```

```
SSEC 08/31/2005 Katrina
SSEC 08/31/2005 Katrina
SSEC 08/31/2005 Katrina
SSEC 08/31/2005 Katrina
SSEC 08/31/2005 Maria Katrina
SSEC 09/01/2005 Maria
SSEC 09/01/2005 Maria
SSEC 09/01/2005 Maria
SSEC 09/01/2005 Maria
SSEC 09/01/2005 Maria
SSEC 09/01/2005 Maria
SSEC 09/01/2005 Maria
```

If you don't want to include the title in your labels file, then you can make an image of title that you can include as a pip. This allows you to choose the font and color scheme of your choosing when you make the title image. This is also a nice option

because then you don't need to insert the title into every line of your labels file. Here is an example of a title that was made into an image for pip:


There is a lot of flexibility with the color bars. They are inserted into the playlist.sos file as a pip. Using this function, you can not only set the position, size and transparency, but also when the color bar appears, how long it stays visible, and how quickly it fades in and out. The color bars can be any common image format such as GIF, JPEG, PNG, TIF, etc. Color bars are generally named color_bar in order to keep all of the various images in the file separate.

Adding New Datasets

Once you have a new dataset that you want to put up on the sphere, there are just a couple of steps to follow. First you need to find a place to store the file on the control computer. If it fits into one of the five categories (astronomy, atmosphere, land, models, and oceans), then make a folder for it in that category. At very minimum the folder should contain the raw image or images and a playlist.sos file. There are scripts that you can get that can convert your raw images for a time series into a MPEG4. Make sure that the playlist.sos file is written according to the playlist format listed in the Overview and Basic System Use section. Remember that the playlist.sos file is used in all of the playlists that contain the dataset, so set it how everyone will want to use it. You can personalize it within your own playlists. If you have any other pieces such as labels or color bars or pips, those should go in the folder as well.

In the playlist.sos file, make sure to specify the category. The SOS software uses the category in the playlist.sos file as a tag to populate the library in the SOS Stream GUI. For example, every dataset that has atmosphere listed as its category in its playlist.sos file will appear in the atmosphere playlist in the library. If you forget to specify a category for a dataset, then it will be put into an uncategorized category in the library.

To view your new dataset you can either make a playlist that contains it, or you can update the library and find it the category that you specified. It is a good idea to view and tweak a dataset before using it in a demo, especially it's you've added labels, color bars or pips. Make sure that everything looks good and appears when and where you want it too.

Sharing Datasets

If your site does not have the necessary tools or the expertise to create datasets, you can still get new datasets. NOAA is constantly adding new datasets to their library that are available for download from the FTP site. Collaboration with other Science On a Sphere® users is encouraged and recommended. This is a good way to get help making new datasets. Check out the list of other SOS sites here. Sites are also encouraged to provide the datasets that they create to the NOAA library so that all of the other SOS sites can use them as well. A SOS users group, noaasos, has been created as a Yahoo Group. This is a place to ask questions, get advice and work with other sites. To join, please provide your email address to the NOAA SOS team in Boulder, CO.

Appendix A

## Helpful Links

Science On a Sphere® Website: http://sos.noaa.gov/

Public FTP site: ftp://public.sos.noaa.gov/

Private FTP site: ftp://ftp.sos.noaa.gov/

Playlist Format: http://sos.noaa.gov/docs/pl_3_1_1.html

Existing Sites: http://sos.noaa.gov/news/sos_sites.html

Content Creation: http://sos.noaa.gov/docs/content_creation.html

Science On a Sphere® FAQ: http://sos.noaa.gov/docs/faq.html

SOS How To: http://sos.noaa.gov/support/howto.html

Linux Red Hat Website: http://www.redhat.com/rhel/

SOS Yahoo Users Group: http://tech.groups.yahoo.com/group/noaasos/